BIOLOGY OF CERTAIN SUMATRAN SPECIES OF ATROPHANEURA, TROGONOPTERA, AND TROIDES (LEPIDOPTERA, PAPILIONIDAE)

BY

R. STRAATMAN

Division of Entomology, Brisbane, Australia

AND

E. J. NIEUWENHUIS

Rotterdam

Introduction

The field notes and descriptions in this paper were made by the first author in Indonesia, from 1947 till 1954. Some of the specimens, collected together with food plants were brought to Holland and left in the care of the second author who secured the kind help of the Rijksherbarium of Leiden for the identification of certain food plants. Some preserved larval material was also sent to Professor Dr. C. L. Remington, of Yale University, New Haven, U.S.A.

The present descriptions are based on specimens that were reared in north-eastern Sumatra, at Laut Tador and Gedong Biara Estates in 1952—1954.

As previous figures by other authors differ from our observations while no mention is made of the earlier instars, it appears useful to redescribe various stages.

As to the literature on the subspecies in question, we have quoted the original description of the adult, as well as Seitz, "Die Groszschmetterlinge der Erde", which work is in so many hands. Furthermore we have refered to papers, dealing with the biology (larva and pupa) of the species, to which our subspecies belong.

Atrophaneura neptunus sumatrana Hagen 1894

Hagen (1894), p. 21 (*Pap. neptunus* var. *sumatrana*).
Jordan, in Seitz (1908), vol. 9, p. 33, pl. 16c ♀ (*Papilio*).

The egg. The egg is brown. It is strongly ribbed longitudinally, flattened at the base, and covered with a sticky substance. Eggs are deposited singly at the base of the hairy stems of the host.

The 1st instar larva. This instar is white with small irregular dark spots. The tubercles are fleshy but rather short, grey, with bright red tips.

The intermediate instars (fig. 1). The ground colour is very pale pink, almost white. The dark markings are larger than in the first instar, but varied in size. The darker specimens show a white saddle-mark on the 4th, and the lower part of the 3rd abdominal segments. On the back is a narrow longitudinal stripe.

The thoracic segments each carry 8 tubercles, while the abdominal segments have 6, the most ventral tubercles being rather short and sometimes barely discernible. Their colour is dark grey, with the exception of the tubercles on the 4th and the 7th abdominal segments which are white, and also slightly longer. All the tubercles are red-tipped.

The final instar (fig. 2). In this instar the ground colour varies from light to dark pinkish grey with irregular dark markings. The saddle mark is more distinct, broad, and white, and extends from between the dorsal tubercles of the 4th abdominal segment to the base of the prolegs of the 3rd. The tubercles of the 1st thoracic segment are white and are joined by a transverse white collar.

The larvae were usually found single, and isolated.

The pupa (pl. 6 fig. 1). The pupa is light brown. The basal halves of the wing cases are paler than the distal portions. The dorsal abdominal appendages are shorter than in *Atrophaneura aristolochiae* (see below) but longer than in *A. coon*. As in the latter species there are irregular white dorsal markings. However, in contrast to these two species there are no red dorsal spots marking the remains of the osmeterium.

The pupa is generally found at the base of the stem of the food plant, only a few inches above the ground. The imago emerges after 21 to 22 days.

The food plant. The food plant belongs to the genus *Thottea,* (subfamily Apamaceae, fam. Aristolochiaceae). It grows very locally in wet, shady places in open rain forests. In Sumatra there are various species of *Thottea* which have separate geographical ranges and do not appear to overlap.

Atrophaneura aristolochiae antiphus Fabr. 1793

FABRICIUS (1793), p. 28 (*Papilio*).
JORDAN, in Seitz (1908), vol. 9, p. 38—39 (*Papilio*).
HORSFIELD (1828), pl. 3, fig. 17 (larva) (*Pap. polydorus* Goeze).
HORSFIELD & MOORE (1857), p. 94, pl. 2, fig. 5 (larva), fig. 5a (pupa) (*Pap. diphilus* Esper, Java).
MOORE (1881), p. 151, pl. 57, fig. 2a (larva), fig. 2b (pupa). (*Menelaides ceylonica* Moore, Ceylon).
DEWITZ (1882), p. 264, pl. 9, fig. 3a (larva), fig. 3b (pupa). The figure of the larva is probably wrong (*Pap. kotzebuea* Eschsch., Philippines).
HAGEN (1894), p. 20, pl. 1, fig. 1 (larva).
MOORE (1902), p. 180, pl. 442, fig. 1 (larva and pupa). (*Menelaides aristolochiae* F., India).
BELL (1911), p. 1132—1133, pl. D[1], fig. 24. (*Pap. aristolochiae* F., India).
DUPONT & SCHEEPMAKER (1935), p. 27—30, fig. 12 (larva), fig. 13 (pupa). (*Pap. aristolochiae adamas* Zink., Java).
TALBOT (1939), p. 85 (larva), p. 86 (pupa), pl. 1, fig. 3 (larva), fig. 4 (pupa). (*Polydorus a. aristolochiae* F., India).
WOODHOUSE (1949), p. 174, pl. 46, fig. 2 (larva and pupa). (*Polydorus aristolochiae ceylonicus* Moore, Ceylon).

The final instar and the pupa of this species have been described previously by various authors, but no mention was made of the earlier instars or life history.

The egg. The egg is pale reddish brown, flattened at the base and is much smaller than in the previously described species. It is usually deposited on the flowers or the leaves of the food plant, but it may be deposited on other objects,

such as dry twigs, grass or stones which are in the immediate vicinity of the host plant. The incubation period is approximately 8 days.

The 1st instar. Tht ground colour of the 1st instar larva is dark reddish brown; there are short stiff black hairs on all segments, and a faint yellow saddle mark on the 3rd abdominal segment.

The 2nd to last instar larva. The ground colour of these stages is affected by the food of the larvae. Thus, larvae feeding on flowers have a wine-reddish colour while those feeding on the leaves tend to be pinkish grey. The saddle mark is very distinct and pure white. It extends from the dorsal tubercles of the 3rd abdominal segment down to the base of the prolegs of the same segment. There are 6 tubercles on each of the thoracic segments, and 4 on the abdominal segments, all of which are approximately of the same length. They are bright red in colour, except those on the 3rd abdominal segment which are white.

The pupa (pl. 6 fig. 2). The ground colour of the pupa is brown to beige, with irregular white dorsal spots. In the newly formed pupa the remains of the osmeterium are present as two dorsal red spots. Tht abdominal segments each carry a pair of leaflike appendages. Pupation occurs either on the food plant or on the stems of other nearby plants. The imago emerges after 18 to 20 days.

The food plant. This species is oligophagous, feeding on various members of the Aristolochiaceae. However, there seems to be a preference for certain host plants, which varies locally. Thus, at Gedong Biara Estate, the larvae of this species were mainly observed on *Apama tomentosa* and on *Thottea* spp. Although females were observed to oviposit on a large species of *Aristolochia,* also inhabited by *Trogonoptera brookiana,* this invariably proved to be fatal to the young larvae, which were never able to survive beyond the 2nd instar.

Atrophaneura coon delianus Fruhst. 1895

FRUHSTORFER (1895), p. 196 (*Pap. doubledayi* d.).
JORDAN, in Seitz (1908), vol. 9, p. 34, pl. 16 ♂ ♀.

The egg. The egg is pinkish brown, flattened at the base, but more rounded than in *Atrophaneura neptunus* or *A. aristolochiae.*

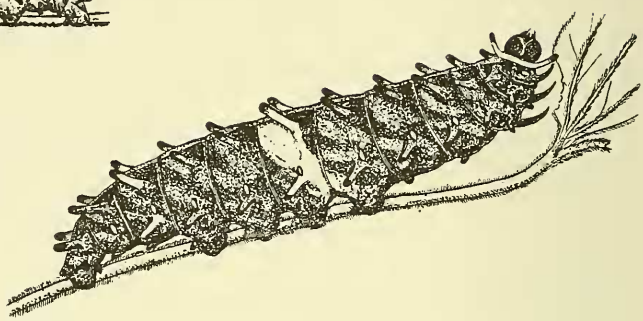
The eggs are generally deposited on the flowers and younger shoots of the food plant, but also on various objects near the host, such as stones, dead twigs or leaves. The incubation period is approximately 10 days.

The 1st instar larva. This instar has a reddish brown ground colour, without markings. There are no spines, but each segment carries very short yellow tubercles.

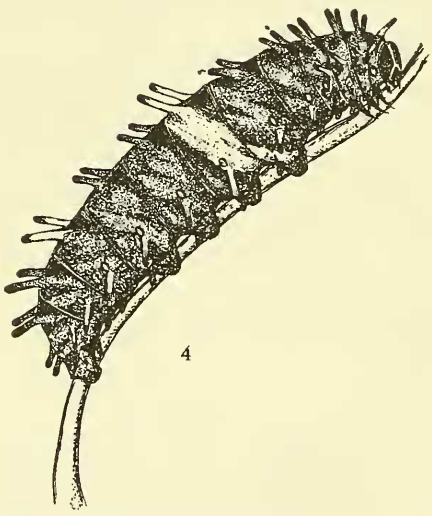
The intermediate instars (fig. 3). In these instars the ground colour of tht larva is pinkish grey with irregular dark markings; there is a distinct pinkish white saddle mark extending from the dorsal region of the 4th abdominal, down to the base of the prolegs of the 3rd abdominal segment. Most of the tubercles are now dark grey, but those of the 4th and the 7th abdominal segments are white. All the tubercles are tipped with wine-red.

The final instar (fig. 4). In this instar the ground colour varies from dark reddish grey to almost black, marbled with black triangular spots and stripes.

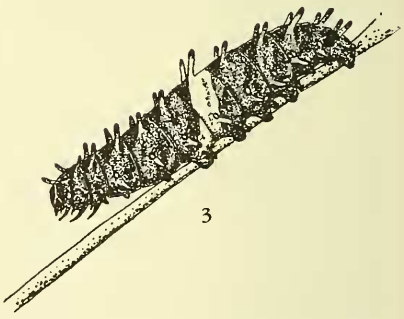
1



2



4



3

Figs. 1—4. Larvae of Papilionidae from Sumatra. 1. *Atrophaneura neptunus sumatrana* Hagen, fourth instar. 2. The same, mature. 3. *Atrophaneura coon delianus* Fruhst, fourth instar. 4. The same, mature. 1 1/3 natural size.

The saddle mark is very distinct, broad and pinkish white. The tubercles are relatively longer than in the previous instars, but of the same colour; those of the 2nd, 3rd, 5th, and 6th abdominal segments are slightly shorter than the others.

The full-grown larva often betrays its presence by cutting through the stems of the food plant, about 3 to 4 cm above the ground, thus causing the upper part of the stem, carrying younger leaves, to fall off and wither. The larva then consumes the basal part of the stem.

Despite considerable differences in adult coloration, *Atrophaneura coon coon* F. and *A. coon delianus* Fruhst. are generally accorded only subspecific rank.

In this connection, however, it should be noted that constant differences also exist between the larval and pupal stages of the two forms. These differences were particularly evident when the two forms were reared simultaneously in Sumatra, *A. coon coon* having been imported from Java for the purpose. This latter form is known to occur also in Sumatra, but only in the southern part of this island (*palembangensis* Rtschld.) thus its geographical range in Sumatra does not seem to overlap that of *A. coon delianus*.

The pupa (pl. 6 fig. 3). The pupa is light brown with dorsal white spots. In the freshly formed pupa two drops of red liquid mark the remains of the larval osmeterium, and observations suggest that these might play an important part in protecting the newly formed pupa from he attack of ants. Thus in larvae which pupated in dry conditions ,the liquid dries up so as to form two bright red spots and many of such pupae were attacked by ants before hardening. However, if larvae pupated under wet conditions the red liquid dissolved in the water and spread over the surface of the pupa; such pupae were not attacked by ants. Handling these pupae left an extremely bitter taste on the fingers.

The forward directed cranial projections are curved downward in this species while the dorsal appendages are more rounded and slightly smaller than in *A. neptunus*. The adult emerges after 21 to 23 days.

The food plant. This species is monophagous, feeding on *Apama tomentosa*. In nature, females were often observed to oviposit on various species of *Aristolochia* and *Thottea,* but the larvae were never able to survive beyond the 1st instar on these plants.

Parasites and predators. Although several hundred pupae were collected in the field, none of these was found to be parasitized, but in the wet season many pupae were found dead, apparently attacked by a fungus disease. Large numbers of larvae were destroyed by lizards, tree frogs, large spiders, ants and large wasps.

Atrophaneura sycorax sycorax Grose Smith 1855

Grose Smith (1885), p. 247.
Jordan, in Seitz (1908), vol. 9, p. 29, pl. 17a ♂, b ♀.

The late Dr. Toxopeus (1936) was of the opinion that *Atrophaneura sycorax* Grose Smith, and *A. priapus* Bsd., of Java are conspecific. However, it should be noted that in addition to the marked morphological differences that exist between these two forms, they also occur in very different habitats. *A. sycorax* is found in the lowland areas of Malaya and Sumatra from sea level up to about 2,000 feet, while *A. priapus* is exclusively a mountain species; we consider that a more close relationship might exist between *Atrophaneura priapus* and *A. hageni* Rogenh., the latter coming from the mountains in Sumatra. These two species however show a difference in behaviour. The males of *A. hageni* leave the forest as soon as the morning mist lifts from the mountain-side and fly swiftly and low over open country, such as tea plantations. During this time they have not been observed to visit flowers, by mid-day they return to the forest. In contrast the males of *A. priapus* were frequently seen feeding on *Latana* flowers growing close to the forest; they are much slower in their flight.

The egg. The egg is large, round and not flattened at the base. The colour is pearly grey. It is generally deposited at the top of a young shoot of the food plant. The larva hatches after 8 or 9 days.

The 1st instar larva. All the larval instars are rather similar in appearance. The first instar larva has a reddish grey ground colour, with irregular dark markings. The white saddle-mark is present and distinct, running from the dorsal region of the 4th abdominal to the prolegs of the 3rd abdominal segments. The tubercles are of various length, those of the 3rd, 4th, and 8th abdominal segments being the longest and white in colour. Of the remaining tubercles, those on the 2nd abdominal segment are the shortest, while those on the 5th and the 6th abdominal are slightly longer, the others being of intermediate length. All these tubercles are dark grey with red tips.

Intermediate and final instars (fig. 5). In the intermediate instars the larva grows progressively darker and the tubercles relatively longer. In the final instar the ground colour is a dark reddish grey, the darker markings almost black and triangular, while the conspicuous white saddle mark is dusted with grey. The head is large, black and shiny and has a yellow epicranial suture.

The pupa (pl. 6 fig. 4). The pupa is very similar to that of *A. aristolochiae* but much larger. Dorsally there are white markings, but there is no visible residue of the osmeterium. The appendages are very long, leaf-like and bent downward. The pupa is usually attached to the margin of a leaf, never on the underside; less frequently it is found on stems adjacent to the food plant. The imago emerges after 23 to 25 days.

The food plant. This species is apparently monophagous and feeds on a tall species of *Thottea,* a plant with irritant hairs on the leaves and the stems. It grows very locally in damp shady areas of the forest and may reach a height of 3 metres.

The larvae of this species are common in October and November and are often found in company with those of *A. neptunus sumatrana* Hagen and *Troides amphrysus ruficollis* Butler. In other months of the year the larvae are very rare or even completely absent and this applies also to the other species already described. From March to August none of the early stages ware ever recorded and in this "quiet period" the food plants developed their strongest growth, the new shoots being able to develop without damage by the larvae. It has not been possible, however, to observe whether the complete absence of so many species in all their forms during several months of the year was due to a migration to other areas.

Trogonoptera brookiana trogon Sn. v. Voll. 1860

SNELLEN VAN VOLLENHOVEN (1860), p. 67—70, pl. 6 ♂ (*Papilio trogon*).
JORDAN, in SEITZ (1908), vol. 9, p. 17, pl. 7c ♂ (*Papilio*).

Trogonoptera brookiana occurs in Malaya, Borneo, Sumatra and Palawan and several of the early authors have stated that the female is rare. Thus DISTANT (1885, p 331), refers to the information of several collectors who estimated the occurrence of the ratio of the males to the females as about 1000 : 15. Such a great departure from the expected 50 : 50 ratio of the sexes suggests that estimates

have been based on an insufficient knowledge of the occurrence of the female. Wheeler (1940) re-examined this question and concluded that the females fly at a much greater height than the males. He found a ratio of about 20 males to 1 female. In the present work, several hundreds of adults were reared at Gedong Biara Estate (N.E. Sumatra), by the first author; these had a sex ratio of approximately 2 ♂ to 1 ♀.

The larva of *T. brookiana* feeds on a large species of *Aristolochia,* a climbing plant which has bare, ridged corky stems when mature, and which carries its foliage high in the forest canopy. This presumably explains the absence of the females in the lower levels of the forest. Root-stocks of several *Aristolochia* plants, together with the lower parts of the stem, were taken from the forest and replanted in a private garden. After a few months the plants had developed a luxurious growth of young shoots from the previously bare stem. This new growth attracted many females from the nearby forest and it was possible to observe the oviposition and the subsequent development of the larvae at close range.

The egg. The eggs are large, round, and pale reddish-grey. They have an incubation period of 10 to 12 days. They are generally deposited on new shoots of the host plant, but in a number of occasions females were also observed to oviposit on dry twigs or on other plants growing at a small distance from the host plant. This distance was sometimes as great as 20 centimeters.

Many newly hatched larvae were killed by spiders, black ants, tree-frogs, and also drowned in heavy rain, while larger larvae were often attacked by large wasps and also by a bird, the "Beo" (*Gracula religiosa* L), which ate large numbers of them.

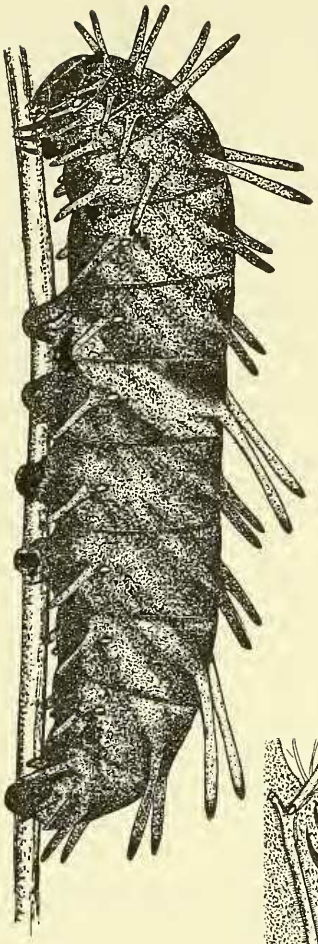
The 1st instar larva. This instar is whitish, with small black dots on the abdominal segments. There are elongated thin tubercles, carrying many branched spine on all the segments. They are black and yellow and give the larva a spiny appearance.

The intermediate instars (fig. 6). There are usually three intermediate instars between the 1st and the final instars giving a total of five larval instars. Certain female larvae, however, have been observed to pass through six larval instars.

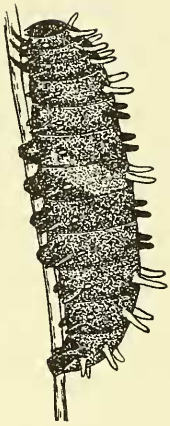
All the intermediate instars have a similar general appearance. The head is black, while the ground colour of the body varies from leaden grey to nearly black. A ligther grey saddle mark is present in most specimens; it runs antero-laterally from the latero-dorsal region of the 4th abdominal to the prolegs of the 3rd abdominal segments.

The thoracic segments have 8 tubercles and the abdominal ones have 6 tubercles each. They are now fleshy and without spines. With the exception of the dorsal tubercles of the 2nd, 3rd, 5th, and 6th abdominal segments, which are black, all the other tubercles are bright orange.

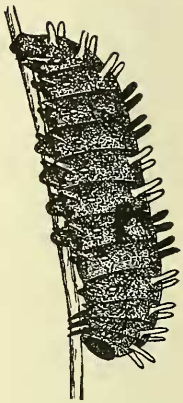
The final instar (fig. 8). In this instar the ground colour varies from dark sooty brown to an ashy grey colour. The light saddle mark is slightly more conspicuous than in the previous instars. The tubercles are longer and more slender, and are often held in an almost horizontal position. The orange tubercles of the previous instars are now ochraceous while the shorter dorsal tubercles of the 2nd, 3rd, 5th, and 6th abdominal segments have a colour similar to the ground



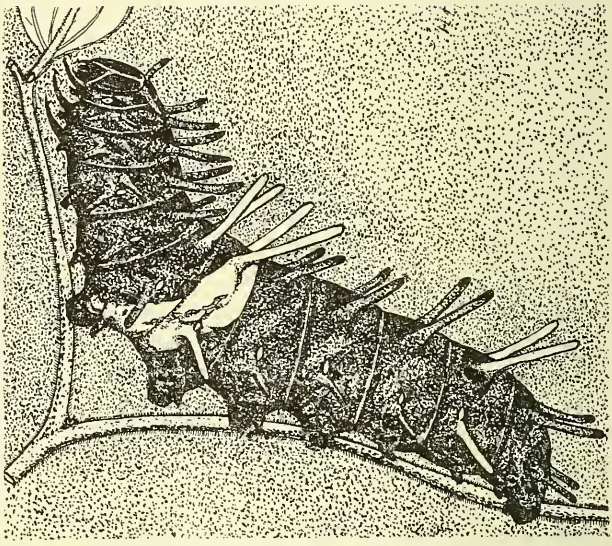
8



6



7



5

Figs. 5—8. Larvae of Papilionidae from Sumatra. 5. *Atrophaneura sycorax sycorax* Gr. Smith, fifth instar. 6. *Trogonoptera brookiana trogon* Sn. v. Vollenh., fourth instar. 7. *Troides amphrysus ruficollis* Butl., third instar. 8. *T. b. trogon* Sn. v. Voll., mature. 1 1/3 natural size.

colour. Laterally the body has a series of darker oblique stripes, running forwards towards the ventral surface. The 4th abdominal segment, which carries the saddle mark, and the ventral surface of the larva are much darker than the ground colour. The head is large and shiny black with a paler epicranial suture. The full-grown larva has a characteristic mode of feeding. When young shoots are available, the larva bites through one after another the petioles of all the leaves commencing at the top of the shoot, so that the leaves fall to the ground. In this way about the length of one meter of the shoot may be stripped of leaves. The larva then returns to the top of the shoot and steadily eats the shoot downwards to the base of the shoot on the main stem.

Food plant. The food plant was identified by the Rijksherbarium at Leiden as a species of *Aristolochia,* not previously represented in the collections of this institute.

Pupation. For pupation the larvae almost invariably chose green twigs, that were making an angle between 40 and 50 degrees to the horizontal. It was observed that if the twig on which the larva was pupating was moved into a horizontal or vertical position, the wing-cases of the resulting pupae were deformed by the silk-girdle.

The pupa (pl. 6 fig. 6). The ground colour of the pupa is an apple green. The outer margin is narrowly bordered with violet and it carries a small marginal square violet spot towards the apex.

Dorsally a yellow saddle mark lies between the wing bases while the abdomen carries two pairs of sharp, pointed, dorsal processes directed towards the midline. When disturbed, the pupa produces a hissing sound by moving the abdominal segments. It has been observed that the pupa keeps its segments pressed together in warm weather, while during the night and also on rainy days the segments are relaxed as far as possible. The pupal stage lasts from 24 to 26 days.

Troides amphrysus ruficollis Butler 1877

Butler (1877), p. 532 (♂ nec ♀) (*Ornithoptera*).
Jordan in Seitz (1908), vol. 9, p. 28. (*Papilio*).
Rippon (1898—1906), p. 47, pl. 51a, figs. 1—6 (*Pompeoptera amphrysus* Cr., Java).
Rippon (1906—1912), pl. 34, figs. 9—10 (pupae) (Java).
Dupont & Scheepmaker (1935), p. 24—26, fig. 10 (larva). (*Troides amphrysus* Cr., Java).
Dupont (1936), p. 28—30, fig. 1 (larva), fig. 2 (pupa). (*Troides amphrysus* Cr., Java).
Talbot (1939), p. 70.
Corbet & Pendlebury (1956), p. 94, fig. 16 (larva), fig. 17 (pupa). (Malaya).

The egg. The pearly egg is large and round. Observations suggest that they are generally deposited on the food plant itself. The incubation period is 13 to 14 days.

The 1st instar larva. The ground colour of the 1st instar larva is black. The body is covered with numerous orange tubercles, bearing short, branched, black spines.

The intermediate instars (fig. 7). There are two or sometimes three intermediate instars between the 1st and the penultimate instars. In these

instars the head and ground colour are black and there is no saddle mark. The thoracic segments carry 8 and the abdominal have 6 tubercles each. They are fleshy, without spines, and are all of equal length. With the exception of the dorsal tubercles of the 2nd, 3rd, 6th, and the 7th abdominal segments, which are black, all the other tubercles are bright orange.

The penultimate and final instars. The large head is of a uniform black colour, but the ground colour of these instars is a dark coffee-brown. There is no saddle mark in this species. The dorsal tubercles of the abdominal segments are slightly longer than the others. Otherwise the tubercles are uniform in size, shape and colour, the latter being the same as the ground colour. They are inclined posteriorly, except for their apices which are bent forwards to form small hooks.

The pupa (pl. 6 fig. 5). The large yellowish-green pupa is strongly marked with greyish veins like in a leaf. It has a broad dorsal lemon-yellow saddle mark, transversely marked with brown streaks. The abdomen carries 3 pairs of sharp dorsal processes, which are directed laterally. The pupal stage lasts from 27 to 30 days.

The food plant. This species is not monophagous and has been found on the same species of *Aristolochia* as *Trogonoptera brookiana*. It was also observed on various *Thottea* species and has been collected, together with *Atrophaneura sycorax* and *A. neptunus* on their food plant. It does not occur, however, on *Apama tomentosa*.

The early stages of this species were observed to be common during September to November, much rarer so from January to March, and were completely absent during the other months.

Acknowledgements

We wish to express our gratitude to Dr. G. O. Stride, Division of Entomology, Commonwealth Scientific and Industrial Research Organization, for his assistance in the preparation of the final manuscript and also to Mr. I. F. B. Common, of the same Division for his comments during the preparation of the manuscript.

We are indebted furthermore to Dr. S. J. van Ooststroom and Dr. R. C. Bakhuizen van den Brink of the Rijksherbarium at Leiden for their valuable help with the identification of the foodplants.

References

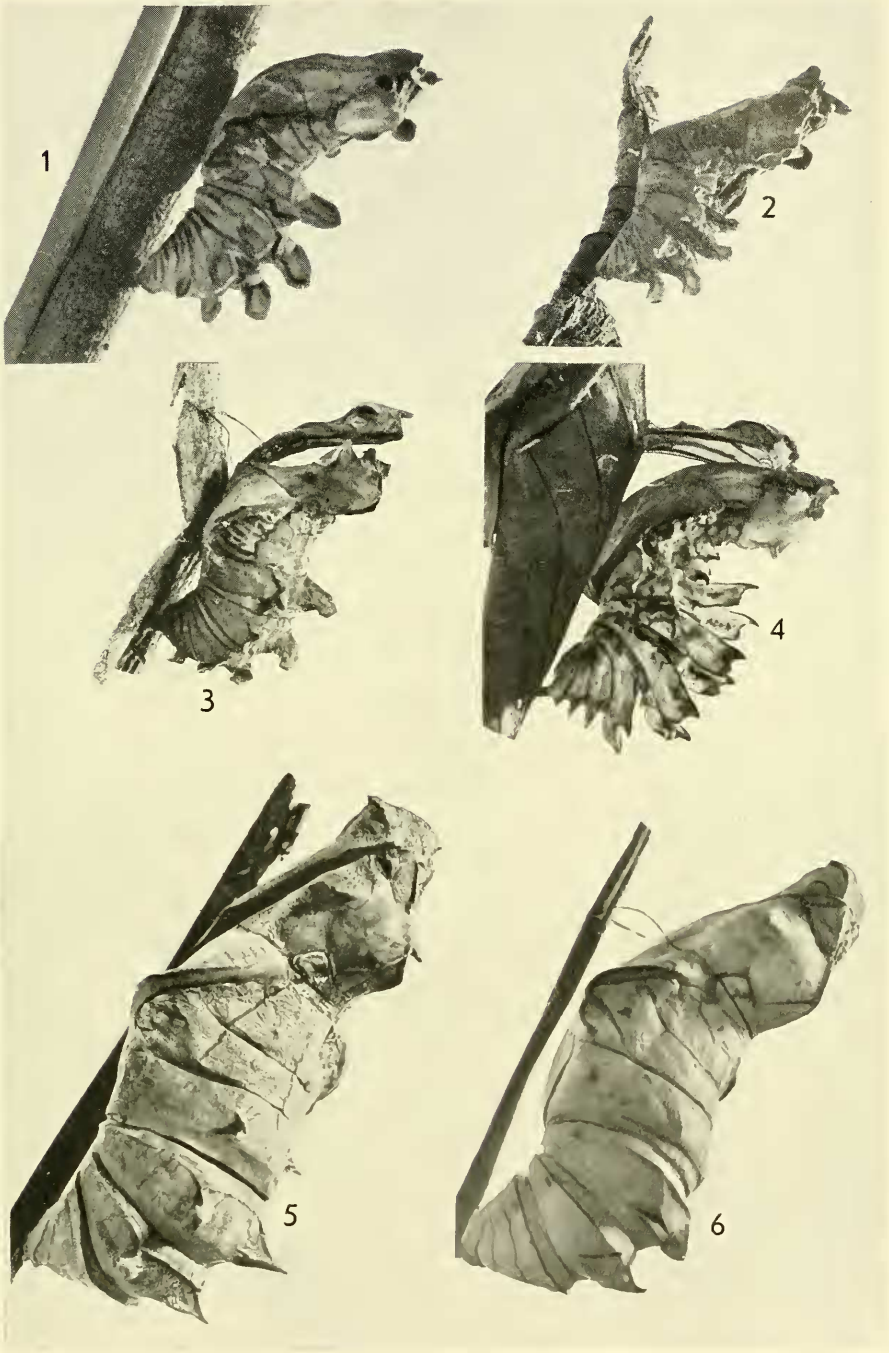
Bell, T. R., 1911, "The common butterflies of the plains of India". Journ. Bombay Nat. Hist. Soc., vol. 20, p. 1115—1136, pls. D-1, D-5.

Butler, A. G., 1877, "The butterflies of Malacca". Trans. Linn. Soc. Lond., 2nd series, vol. 1, p. 535—568, pl. 68—69.

Corbet, A. S. & Pendlebury, H. M., 1956, "The butterflies of the Malay Peninsula", 2nd edition.

Dewitz, H., 1882, "Beschreibung von Jugendstadien exotischer Lepidopteren". Nov. Act. Ac. Nat. Cur., vol. 44, p. 245—272, pl. 8—9.

Distant, W. L., 1882—1886, "Rhopalocera Malayana".



Pl. 6. Exuvia of Sumatran Papilionidae. Fig. 1. *Atrophaneura neptunus sumatrana* Hagen. Fig. 2. *A. aristolochiae antiphus* Fabr. Fig. 3. *A. coon delianus* Fruhst. Fig. 4. *A. sycorax sycorax* Gr. Smith. Fig. 5. *Troides amphrysis ruficollis* Butl. Fig. 6. *T. brookiana trogon* Sn. v. Voll. 1½ × natural size